EXHIBIT C

IPR2021-00179
PATENT NO. 8,407,273

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GOOGLE LLC,

Petitioner,

v.

SINGULAR COMPUTING LLC,

Patent Owner.

Patent No. 8,407,273
Filing Date: February 17, 2012
Issue Date: March 26, 2013

Inventor: Joseph Bates
Title: PROCESSING WITH COMPACT ARITHMETIC PROCESSING ELEMENT

PATENT OWNER'S PRELIMINARY RESPONSE

Case No. IPR2021-00179

floating-point processor that is designed to be able to perform high-precision calculations when required. By contrast, the invention of the '273 Patent rejects Dockser's premise about the need for full precision operation and is based instead on the insight that by leveraging the speed and simplicity of LPHDR execution units, computers can perform *only* imprecise calculations and still produce valuable results.

II. THE '273 PATENT

The '273 Patent is entitled "Processing with compact arithmetic processing element" and issued on March 26, 2013. The '273 Patent claims priority, through its parent application, to U.S. Provisional Patent Application No. 61/218,691, filed on Jun. 19, 2009. At a high level, the '273 Patent is directed to technology for performing low-precision, high-dynamic-range operations. *See* Ex. 1001 ('273 Patent) at 2:14-31.

The '273 Patent's inventor, Dr. Joseph Bates, recognized that even though then-modern processors contained hundreds of millions of transistors, they could perform only a handful of operations per clock cycle:

> Consider a modern silicon microprocessor chip containing about one billion transistors, clocked at roughly 1 GHz. On each cycle the chip delivers approximately one useful arithmetic operation to the software it is running. For instance, a value might be transferred between registers, another value

> might be incremented, perhaps a multiply is accomplished. This is not terribly different from what chips did 30 years ago, though the clock rates are perhaps a thousand times faster today.

'273 Patent at 1:52-60.

As Dr. Bates explained, a large portion of this inefficiency comes from using transistor-intensive high-precision arithmetic units:

> As described above, today's CPU chips make inefficient use of their transistors. For example, a conventional CPU chip containing a billion transistors might enable software to perform merely a few operations per clock cycle. Although this is highly inefficient, those having ordinary skill in the art design CPUs in this way for what are widely accepted to be valid reasons. For example, such designs satisfy the (often essential) requirement for software compatibility with earlier designs. Furthermore, they deliver great precision, performing exact arithmetic with integers typically 32 or 64 bits long and performing rather accurate and widely standardized arithmetic with 32 and 64 bit floating point numbers. Many applications need this kind of precision. As a result, conventional CPUs typically are designed to provide such precision, using on the order of a million transistors to implement the arithmetic operations.

'273 Patent at 3:7-3:22.

However, Dr. Bates realized that such high-precision, inefficient, components were not necessary for all applications, including many valuable ones:

> There are many economically important applications, however, which are not especially sensitive to precision and that would greatly benefit, in the form of application performance per transistor, from the ability to draw upon a far greater fraction of the computing power inherent in those million transistors. Current architectures for general purpose computing fail to deliver this power.

'273 Patent at 3:23-29.

The '273 Patent thus is directed away from prior art computers, which are based on high precision execution units that take up space and are wasteful of transistors, and towards computers based on low precision, high dynamic range (LPHDR) execution units:

> Embodiments of the present invention efficiently provide computing power using a fundamentally different approach than those described above. In particular, embodiments of the present invention are directed to computer processors or other devices which use low precision high dynamic range (LPHDR) processing elements to perform computations (such as arithmetic operations).

'273 Patent at 5:63-6:2.